Fine-grained NUMA-aware parallel scheme for anisotropic mesh adaptation

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Abstract

In this work, we provide a fine-grained parallel scheme for anisotropic mesh adaptation on *non-uniform memory access* (NUMA) multicore architectures. Data dependencies are expressed by a task graph for each remeshing stage. Concurrency is extracted through speculative parallel graph coloring [2]. To ensure data consistency, tasks are structured into bulk-synchronous steps using the *queuing shared-memory* (QSM) bridging model [3,4]. Thus interleaved mesh requests/updates patterns are avoided. To ensure performance portability, theoretical guarantees on asymptotical execution time and load imbalance are given. Furthermore, the impact of degree distribution and memory accesses penalties on scalability is highlighted.

Contributions

EXISTING SCHEMES

- ✗ coarse-grained: almost 80% of the state-of-the-art. manycore era: serial kernel based schemes will be inefficient.
- ✗ fine-grained: no performance portability guarantees, limited scalability in NUMA context.

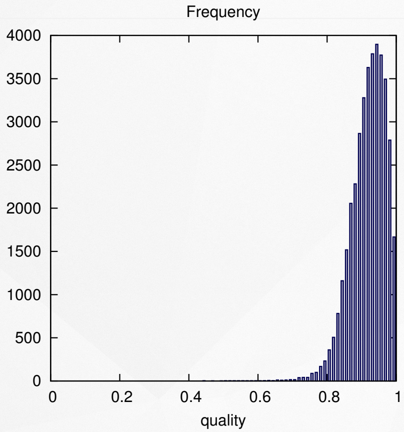
CHALLENGES.

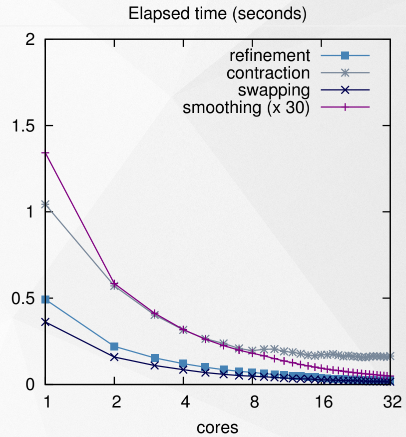
- memory-bound: requires a large amount of prefetched data to reduce stalled CPU cycles.
- irregular: data dependencies cannot be statically resolved.
- anisotropy: irregular degree distribution ⇒ load imbalance

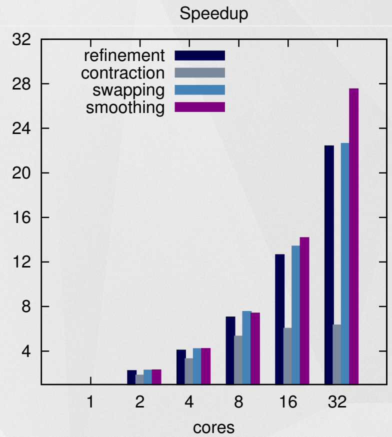
OUR SCHEME

- ✓ scalable, multi-dimensional, lock-free and race-free scheme: ☞ generalizable to other irregular algorithms.
- ✓ theoretical background ⇒ performance predictability.

Results







stages	Efficiency = (speedup/cores) * 100															
	refinement				contraction				swapping				smoothing			
cores	2	8	16	32	2	8	16	32	2	8	16	32	2	8	16	32
our scheme	110	89	80	70	90	68	39	20	112	88	79	70	113	92	89	87
Pragmatic [5]	91	62	37	22	95	81	68	39	93	60	42	32	96	79	62	42

References

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